ASMINT.068AUS PATENT

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

| | | |
|---|---|---|
| Applicant | : | Haverkort *et al.* |
| App. No | : | 11/213,449 |
| Filed | : | August 25, 2005 |
| For | : | LOW TEMPERATURE SILICON COMPOUND DEPOSITION |
| Examiner | : | Ron Everett Pompey |
| Art Unit | : | 2812 |

## DECLARATION OF CORNELIUS A. VAN DER JEUGD UNDER 37 C.F.R. § 1.132

**Mail Stop AF**
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I, Cornelius A. van der Jeugd, do hereby declare and say as follows:

1. I am currently employed as a General Manager for ASM International, N.V. ("ASM") in Leuven, Belgium, where I have overall management responsibilities for ASM's process application development department. The assignee of the above-referenced patent application is accordingly my employer and I am a inventor on the patent application referenced above. My department develops chemical vapor deposition ("CVD") processes for semiconductor applications. I have worked in the field of semiconductor manufacturing for the past 15 years, mostly developing CVD processes. I have been an author of over thirty scientific publications about semiconductor manufacturing. I am an inventor on 14 U.S. patents involving semiconductor manufacturing. Lists of some of my publications and patents are provided in the attached curriculum vitae. Before working in the semiconductor industry, I earned a Ph.D. in



3/19/2007

Experimental Physics from the University of Technology, Delft, the Netherlands. My Ph.D. thesis focused on a CVD process in which silane was used as a precursor.

2. I have read and understand the amended claims in Haverkort *et al.*'s patent application. I understand that the claims recite forming a layer of a silicon compound that is highly uniform and/or conformal. The silicon layer is formed by using trisilane to deposit a silicon layer. The silicon layer is exposed to a reactive species to form the silicon compound. The steps of forming the silicon layer and exposing the layer to a reactive species can be repeated in cycles to build up the thickness of the silicon compound layer.

3. I am familiar with the examination of Haverkort *et al.*'s patent application, including the Office Action mailed on December 26, 2006. I understand that the Office Action states that the claims of Haverkort *et al.*'s patent application were rejected in view of U.S. Patent Application Publication No. 2003/0059535 ("Luo *et al.*"), U.S. Patent No. 4,363,828 ("Brodsky *et al.*"), U.S. Patent No. 6,503,846 ("Niimi *et al.*") and statements made in Haverkort *et al.*'s patent application ("APA"). I understand that the Examiner concluded that the ordinary engineer would find that some of the claims were obvious in view of Luo *et al.* when read in conjunction with Brodsky *et al.* I understand that the Examiner has also concluded that the ordinary engineer would have found that some of the other claims were obvious in view of Luo *et al.* when read in conjunction with Brodsky *et al.*, APA and/or Niimi *et al.* Luo *et al.* discloses using hexachlorodisilane (HCD) to form a silicon layer and reacting the silicon layer with another reactant to form a silicon compound. Silane and disilane are provided in a list of alternatives for HCD. Luo *et al.* do not discuss the type of results that may be achieved with silane or disilane. The Examiner stated that the ordinary engineer would have considered it obvious to substitute trisilane for silane or disilane, when Luo *et al.* is read in conjunction with Brodsky *et al.*, which discloses using trisilane to form hydrogenated amorphous silicon. However, for the reasons below, I disagree with the Examiner's conclusion that the ordinary engineer would have considered trisilane to be workable in Luo *et al.*'s process or generally as a subsitute for silane or disilane for any and all applications.

4. Trisilane has been known to be significantly more reactive and unstable than silane or disilane. Indeed, trisilane has been known to be pyrophoric and has been reported to detonate in air. *See, e.g.*, the attached Material Safety Date Sheet for trisilane, page 6.



3/19/2007

5. Trisilane has been known speculatively as a theoretical silicon precursor, and there have been studies experimenting with trisilane for specialized applications. For example, this is indicated by Brodsky *et al.*

6. While known theoretically as a possible silicon precursor, the ordinary engineer would not have expected, at the time of the invention, that trisilane could successfully be used to deposit high quality silicon compound layers, having high conformality and/or high uniformity, in the semiconductor environment, especially in a cyclic process where thin silicon layers are formed in each cycle. For example, the ordinary engineer would have expected that the high reactivity of trisilane would have caused poor conformality and uniformity, as the trisilane reacted violently in a deposition chamber. Because of its instability and reactivity, trisilane would have been expected to deposit uncontrollably on a substrate. Such an uncontrollable deposition would have been expected to cause acute depletion effects, in which more material would have been expected to deposit on regions of the substrate closest to the entry point of trisilane into the deposition chamber. Moroever, the high reactivity would have been expected to make difficult the formation of thin high quality layers, such as the 3-30 Å layers disclosed by Haverkort *et al.* In addition, the high reactivity would have been expected to cause some gas phase reactions, such that some agglomeration of silicon-containing material would have been expected to occur. Some of this agglomerated material would have been expected to deposit on the substrate. These masses of material would have been expected to cause non-uniformities in deposited layers and to reduce the conformality of the layers, since they would cause undesirably large localized deposits of material.

7. The concerns discussed in paragraph 6 would have been expected to be heightened in hot wall batch furnaces. The temperatures in such furnaces are highly uniform, from the walls to the substrates in the furnace's reaction chamber. Thus, because of the high reactivity of trisilane, deposition on the walls of the furnace and gas phase reactions would have been expected to occur. Deposition on the walls would have been expected to generate particles, as deposited films flake off the walls after multiple thermal cycles, after being disturbed by gas flow inside the chamber, etc. In addition, gas phase reactions would have been expected to cause agglomeration of material in the gas phase. Some of these agglomerations would have been expected to deposit on a substrate, thereby causing poor process results. Moreover, batch



KLLO 3/19/200

furnaces have a large volume and a long path length between the surface of a substrate and the entry point of trisilane into the process chamber. This long path length would be expected to increase the occurrence of any gas phase reactions. In addition, the high reactivity of trisilane would have been expected to cause depletion effects as the concentration of trisilane diminishes due to deposition on surfaces closer to the entry point of the trisilane into the process chamber. These depletion effects could be acute in a batch reactor, because of the large volume of the reactor and the large path lengths between the entry point of the trisilane and a substrate surface. Because of factors such as those discussed above, the skilled artisan would have expected trisilane to form films with poor uniformity and conformality.

8. In short, before ASM engineers developed processes to form high quality layers using trisilane, the ordinary engineer would have expected depositions with trisilane to give unacceptably poor deposition results compared to silane and disilane. As a result, the ordinary engineer would not have been motivated to work with trisilane for known semiconductor applications in which high quality layers are desired.

9. In contrast, I understand that Haverkort *et al.* have developed a process using trisilane to form silicon compound layers of exceptionally high quality. I understand that Haverkort *et al.*'s process allows the formation of silicon compound layers that have a thickness non-uniformity of about 5% or less and a step coverage of 80% or greater. This non-uniformity and conformality can be maintained for layers which are about 3-30 Å thick. In my considered opinion, these results are unexpected, especially in light of the skepticism I have discussed above.

10. Instead of forming thick layers, which may increase throughput, Haverkort *et al.* teaches that thin silicon layers can be formed and then reacted to form a silicon compound layer. Haverkort *et al.* indicates that layers of about 3-30 Å thick have benefits for forming silicon compounds layers. The thin layers can be more completely reacted than thicker layers. However, reactants can diffuse through the thin layers to react with and damage underlying structures. Also, if the thin layers have nonuniform thicknesses, completely reacting the layer may require diffusion of reactants through the thickest part of the layer, which will result in undesired diffusion of the reactant into the substrate at the thinnest parts of the layer. Haverkort *et al.* discloses that, because their process allows trisilame to form exceptionally uniform thin



3/19/2007

layers, complete reaction of the silicon layer can be accomplished with negligible diffusion of reactant into the substrate. In my considered opinion, the skilled artisan would not have expected that trisilane could be applied with such advantages.

11. I have read and understand Brodsky *et al.* Brodsky *et al.* would not have altered the previous expectations of the ordinary engineer. Brodsky *et al.* discloses bulk deposition of amorphous silicon in which large amounts of material are deposited in a short time. Brodsky *et al.* was not concerned with high uniformity and high conformality required by the semiconductor industry in general at the time of the invention, and the ordinary engineer would not have understood Brodsky *et al.* to disclose that trisilane would allow the deposition of silicon layers with high uniformity and high conformality, particularly for very thin layers or in all circumstances.

12. I have also read and understand Luo *et al.* Luo *et al.* discloses a cyclic process for forming silicon nitride layers. Silane or disilane are listed as possible silicon sources. Cyclic processes, in which cycles of flowing multiple reactants into a reaction chamber are repeated to form a layer of material, are known to be relatively slow for forming a layer of a given thickness when compared to typical CVD processes. Various factors may be responsible for this slowness, including to the need to switch gas supplies and to remove gases from a reaction chamber between periods of flowing reactants into a process chamber. In choosing to use a cyclic process, I understand that a primary goal for Luo *et al.* is the formation of high quality layers. Consequently, I understand that, for Luo *et al.*, concerns about film quality override concerns about process speed.

13. It should be noted that while Brodsky *et al.* states that trisilane has a high deposition rate, the ordinary engineer would have expected this high deposition rate to be accompanied by the non-uniformities and contamination I describe above. When this expectation of poor results is balanced against Luo *et al.*'s goal for high quality deposition results, it is my considered opinion that the ordinary engineer would not have been motivated to substitute the silane and disilane listed by Luo *et al.* for trisilane.

14. It should also be noted that Luo *et al.* discourages performing their process in batch reactors. The ordinary engineer will understand that batch reactors are considered "hot wall" reactors, because their walls typically have an elevated temperature that is close to the



[signature] 3/19/2007

process temperature. Luo *et al.* states that all furnaces have a pattern loading effect that causes film non-uniformity. Luo *et al.* also states that its invention uses a cold wall, single wafer process chamber because cold wall chambers have little deposition on the cold walls of the chamber, among other things. Furthermore, Luo *et al.* states that there is less contamination from the cold walls, the temperature of the cold walls can be controlled independently, and the cold wall, single wafer process chamber uses less power than a furnace. As a result, Luo *et al.* states that its process utilizes a cold wall, single wafer process chamber. Because Luo *et al.* consistently disparages batch reactors, it is my considered opinion that the ordinary engineer would understand Luo *et al.* to discourage using batch reactors for its process. Furthermore, in view of Luo *et al.*'s discussion of the significance of deposition on and contamination from batch reactor walls, it is also my considered opinion that the ordinary engineer would be especially discouraged from using trisilane as a silicon precursor in their process, because of the expectations of the ordinary engineer that trisilane would cause increased deposition on and contamination from batch reactor walls.

15. Trisilane would also have been expected to present practical concerns for use in a deposition system. For example, the possibility of detonation has cautioned against use of trisilane, due to concerns about the safety of personnel and damage to equipment. Also, trisilane is a liquid under standard conditions, while both silane and disilane are gases under standard conditions. For typical deposition processes, trisilane is converted into a gas, which adds to the cost and complexity of the deposition system. This added complexity can further increase safety concerns due to the increased pieces of equipment and piping which may fail and, as a result, which increase the possibility of explosions. Because of these safety concerns and the expectations of poor deposition results I have discussed above, the ordinary engineer would have been skeptical of using trisilane in place of silane and disilane for depositions in which high quality results are desired. For these reasons, before the work of engineers at ASM, I am not aware of any disclosures that provide working examples using trisilane to form highly conformal and uniform silicon-containing layers.

16. I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true. I declare that these statements were made with the knowledge that willful false statements and the like so made



3/19/2007

are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Respectfully submitted,

Dated: March 19, 2007

By: C. A. v. d. Jeugd

Cornelius A. van der Jeugd

3503607
030607

## Section 1: Chemical Product and Company Identification

**Material Name:** Trisilane. **Chemical formula:** $Si_3H_8$.

**Synonyms:** Trisilicopropane, trisilicon octahydride

**Manufacturer:** Voltaix, Inc.: Post Office Box 5357, North Branch, New Jersey 08876-5357 USA
Voice: 908-231-9060 or 800-VOLTAIX, Facsimile: 908-231-9063



## *Section 2: Composition/Information on Ingredients*

| Component | CAS Registry Number | Molar (volume) concentration | Exposure Guidelines |
|---|---|---|---|
| **Trisilane** | 7783-26-8 | 100% | 5 ppm TWA (See Section 11) |

## *Section 3: Hazards Identification*

**Emergency Overview**

Trisilane is a colorless liquid with a repulsive odor. It is flammable and pyrophoric (autoigniting in air), but may form mixtures with air that do not autoignite, but are flammable or explosive. The immediate health hazard is that it may cause thermal burns. Trisilane is violently reactive with oxidizers and halogens.

**NFPA 704 Rating (determined by Voltaix, Inc.): Health** 0 **Fire** 4 **Reactivity** 1 **Special** None

**Potential Health Effects**

**Routes of Exposure**: The primary route of exposure at low concentrations is inhalation. At higher concentrations, the material ignites spontaneously in air, creating a thermal burn risk, but reducing the toxic inhalation hazard.

**Lengths of Exposure:** No data are known to Voltaix, Inc.

**Severity of Effect:** Unknown, presumed to depend on concentration and duration.

**Target Organs:** None identified.

**Type of Effect:** No effect identified.

**Signs and Symptoms of Exposure:** Suspected to cause headache and nausea.

**Medical Conditions that may be Aggravated by Exposure:** None identified.

**Reported Carcinogenic and Reproductive Effects:** None known to Voltaix, Inc.

## *Section 4: First Aid Measures*

### Inhalation

1) Remove the affected person from the gas source or contaminated area. Note: Personal Protective Equipment (PPE), including positive pressure, self contained breathing apparatus, may be required to assure the safety of the rescuer.

2) If the affected person is not breathing spontaneously, administer rescue breathing.

3) If the affected person does not have a pulse, administer CPR.

4) If medical oxygen and appropriately trained personnel are available, administer 100% oxygen to the affected person.

5) Summon an emergency ambulance. If an ambulance is not available, contact a physician, hospital, or poison control center for instruction.

6) Keep the affected person warm, comfortable, and at rest while awaiting professional medical care. *Monitor the breathing and pulse continuously.* Administer rescue breathing or CPR if necessary.

### Skin Contact

Flush with a copious stream of water while removing contaminated clothing. Continue flushing until the professional medical assistance arrives, but for no less than fifteen minutes. Treat thermal burns by assuring that affected area is cool by flushing with cool water, and then apply dry sterile dressings. If the patient is burned on the face, neck, head, or chest, assume that the airway may also have been burned and obtain professional medical assistance immediately.

### Eye Contact

Flush continuously with clean water until the professional medical assistance arrives, but for no less than thirty minutes. Continuation of flushing until patient is transferred to an ophthalmologist or emergency physician is recommended.

### Ingestion

This is not a normal route of exposure due to the pyrophoric nature of the material. May cause thermal burns to gastrointestinal tract. See First Aid Measures for Skin Contact and seek professional medical assistance immediately

### Chronic Effects

None is known to Voltaix, Inc.

### Note to Physicians:

The reaction product of Trisilane and air is silicon oxide (silica). Therefore, skin and eye burns should be irrigated to the extent the physician feels necessary to remove the silicon oxide to an acceptable degree. Thereafter, treatment for burns is as usual.

## *Section 5: Fire Fighting Measures*

### Flammability and Explosivity

**Flash Point:** Unknown, pyrophoric at room temperature.

**Flammability Limits in Air:** Unknown, pure trisilane is pyrophoric.

**Autoignition Temperature:** Less than 54 °C (130 °F), this material is pyrophoric.

**Flammability Classification (per 29 CFR 1910.1200):** Pyrophoric liquid.

**Known or Anticipated Hazardous Products of Combustion:** Silicon oxide.

**Properties that may Initiate or Intensify Fire:** Material is pyrophoric.

**Reactions that Release Flammable Gases:** Decomposition releases hydrogen.

### Extinguishing Media

None.

### Fire Fighting Instructions

The only safe way to extinguish a trisilane fire is to stop the flow of liquid. If the flow cannot be stopped, allow the entire contents of the container to burn. Cool the container and surroundings with water from a suitable safe distance. Extinguishing the fire without stopping the flow of liquid may permit the formation of ignitable or explosive mixtures with air. These mixtures may propagate to a source of ignition.

Excessive pressure may develop in containers exposed to fire, which may result in explosion, regardless of the cylinder's content. Containers with pressure relief devices (PRD's) may release their contents through such devices if the cylinder is exposed to fire. Containers without PRD's have no provision for controlled release and are therefore more likely to explode if exposed to fire.

Positive pressure, self contained breathing apparatus is required for all fire fighting involving hazardous materials. Full structural fire fighting (bunker) gear is the *minimum* acceptable attire. The need for proximity, entry, and flashover protection and special protective clothing should be determined for each incident by a competent fire fighting safety professional.

## *Section 6: Accidental Release Measures*

### Containment

If possible use sandbags to contain and isolate the burning liquid

### Clean Up

Under the CERCLA/RCRA regulations this material is regulated as a hazardous waste or material. Therefore it must be disposed of in a licensed hazardous waste facility in compliance with EPA and other applicable local, state and federal regulations. It should be handled in a manner acceptable to good waste management practices.

### Evacuation

If the release is not contained in an appropriate device or system, all personnel not appropriately protected (see Section 8) must evacuate the contaminated spaces. Consider evacuation of additional areas, as a precaution against the spread of the release or subsequent explosion or fire.

### Special Instructions

Most, but not all, releases of Trisilane into air will autoignite, producing silicon oxide, a white powder that may be suspended in the air if produced in this manner. As all leaks might not autoignite, consider the formation of ignitable or explosive mixtures with air.

## *Section 7: Handling and Storage*

### Handling

Handle this material only in sealed, purged systems. The design of handling systems for hazardous materials is beyond the scope of this MSDS, and should be performed by a competent, experienced professional. Consider the use of doubly-contained piping; diaphragm or bellows sealed, soft seat valves; backflow prevention devices; flash arrestors; and flow monitoring or limiting devices. Gas cabinets, with appropriate exhaust treatment, are recommended, as is automatic monitoring of the secondary enclosures and work areas for release.

Handle sealed gas cylinders in accordance with CGA P-1, *Safe Handling of Compressed Gases in Containers.*

Some material may have accumulated behind the outlet plug. Face the outlet away from you and wear appropriate protective equipment when removing the plug to connect the cylinder to your system.

Never introduce any substance into a gas cylinder. If you believe your cylinder may have been contaminated, notify Voltaix, Inc. immediately. Provide as much information as possible on the nature and quantity of contamination.

This material may be supplied in containers having both liquid and vapor withdrawal outlets and a helium blanket. Opening the liquid outlet without properly venting the helium blanket can cause the liquid to flow out of the container in an unexpected manner. The helium blanket should be vented to an appropriate control device before withdrawing liquid unless the helium blanket is to be intentionally used to propel the liquid from the liquid withdrawal outlet. Any helium vented can contain trisilane product and the vented mixture can be pyrophoric.

### Storage

Store cylinders in accordance with CGA P-1, *Safe Handling of Compressed Gases in Containers*, local building and fire codes and other relevant regulations. Materials should be segregated by the hazards they comprise for storage.

Protect the cylinders from direct sunlight, precipitation, mechanical damage, and temperatures above 55 °C (130 °F).

Ship and store cylinders with the outlet plug and valve protective cap in place.

## *Section 8: Exposure Control/Personal Protection*

**Engineering Controls**

Local exhaust is required. Secondary containment, with appropriate exhaust gas treatment, is strongly encouraged and is required in some jurisdictions.

Monitor the work area and the secondary containment continuously for release of the material. Automatic alerting of personnel and automatic shutdown of flow are appropriate in most applications and are required in some jurisdictions.

Purge all primary containment systems with a nonreactive gas, such as nitrogen, before introducing Trisilane.

**Personal Protective Equipment (PPE)**

**Respiratory Protection:** Positive pressure, full face, air supplied breathing apparatus should be used for work within the secondary containment equipment if a leak is suspected or the primary containment is to be opened, *e.g.*, for a cylinder change. Air supplied breathing apparatus is required for response to demonstrated or suspected releases from the primary containment.

**Eye/Face Protection:** This is usually provided by the respiratory protection equipment. For handling sealed cylinders, wear safety glasses.

**Skin Protection:** Wear appropriate gloves when handling sealed cylinders. Use gloves and other skin protection, as assigned by a competent safety professional, when working within the secondary enclosure with the primary enclosure compromised, *e.g.*, cylinder changing, to protect both from exposure to the material and from fire that may result from its release to the air.

**Other Protection:** Wear appropriate protective footwear when moving cylinders.

**Exposure Guidelines**

Voltaix, Inc. recommends a Time Weighted Average of 5 ppm. (See Section 11.)

## *Section 9: Physical and Chemical Properties*

Notes: 1) "N/A" means not applicable.
2) Unless otherwise specified, properties are reported at 0 °C (32 °F) and 1 atmosphere (1.0 bar, 14.7 psia).

| Property | Trisilane |
|---|---|
| Appearance | colorless |
| Odor | repulsive |
| Physical state | liquid |
| pH | N/A |
| Vapor Pressure | 95.5 Torr at 0 °C (32 °F) |
| Vapor Density | 3.47 g/l @ 52.9 °C |
| Boiling point | 52.9 °C |
| Melting point | -117.4 °C |
| Solubility in water (v/v) | Unknown (decomposes) |
| Specific gravity (liquid) | 0.743 g/cc @ 0 °C |
| Molecular weight | 92.33 |

## *Section 10: Stability and Reactivity*

**Chemical Stability:** Trisilane is less stable than silane and disilane at room temperature and atmospheric pressure.

**Conditions to Avoid:** Sources of ignition, exposure to air. Trisilane has been reported as detonating in air.

**Incompatibility with Other Materials:** Oxidizers, halogens, organohalides,

**Hazardous Decomposition, Reaction and Oxidation (other than burning) Products:** Silicon oxide, silane, hydrogen.

**Hazardous Polymerization:** Has not been observed.

## *Section 11: Toxicological Information*

**Acute Data (by route):** No information on Trisilane's acute toxicity is known to Voltaix, Inc. By analogy with silane, exposure by inhalation may cause headache or nausea. Reaction with air may produce irritation or thermal burns to skin, eyes and mucous membranes. $LC_{50}$, 4-hour, rat for silane is 9600 ppm.

**Chronic and Subchronic Data:** Trisilane is not listed in RTECS; no information on its carcinogenicity is known to Voltaix, Inc.

**Special Studies:** None known.

No published exposure guidelines for Trisilane are known to Voltaix, Inc. Because Trisilane is similar in structure and properties to silane ($SiH_4$), Voltaix, Inc. recommends a Time Weighted Average of 5 ppm, which is the TWA specified by ACGIH, OSHA and NIOSH for silane.

## *Section 12: Ecological Information*

**Ecotoxicity:** None known to Voltaix, Inc.

**Environmental Fate:** None known to Voltaix, Inc.

## *Section 13: Disposal Considerations*

**Classification under RCRA, 40 CFR 261:** This material is not listed.

**US EPA waste number and descriptions:** D001 (ignitability).

**Special Instructions and Limitations:** Treat process and other exhaust streams appropriately before release to the atmosphere.

**Notice:** The information above is derived from Voltaix, Inc.'s interpretation of the US federal laws, regulations and policies concerning the material, as shipped by Voltaix, Inc., at the time this MSDS was prepared. Federal controls are subject to change and state and local controls may also apply. Proper waste disposal is the responsibility of the owner of the waste. The user is encouraged to consult with appropriate experts in developing a disposal plan.

## *Section 14: Transport Information*

**Basic Description.** Pyrophoric liquid, inorganic, n.o.s. (Trisilane), Division 4.2, UN 3194, Packing Group I.

**Additional Information for shipment by water:** IMDG Page Number 4254, MFAG # 760, EmS #4.2-01

**Additional Information for shipment by air:** Transportation by air is forbidden.

## *Section 15: Regulatory Information*

**TSCA Status:** This material is supplied under a "Low Volume Exemption" (40 CFR 723) of the Toxic Substances Control Act. As such, its use is restricted to the formation of silicon and silicon containing compounds and use as a synthesis reagent.

**CERCLA Reportable Quantity (40CFR302.40):** This material is not listed. The Reportable Quantity (RQ) for "Unlisted Hazardous Wastes Characteristic of Ignitability" (D001) of 45.4 kg (100 lbs.) therefore applies.

**SARA Title III Status (Section 302 (40CFR355), Section 311/312, Section 313 (40CFR372)):** No Threshold Planning Quantities (TPQ's) or Reportable Quantities (RQ's) are listed for these substances. The default federal MSDS submission and inventory requirement filing threshold of 4,540 kg (10,000 lbs.) therefore applies.
*Note:* State and local requirements may be more stringent.

## *Section 16: Other Information*

**References**

*Book of SEMI Standards, Facilities Standards and Safety Guidelines.* Mountain View, CA: Semiconductor Equipment and Materials International, 1993.

Borak, Jonathan, M.D., Michael Callan and William Abbott, *Hazardous Materials Exposure: Emergency Response and Patient Care.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1991.

*Effects of Exposure to Toxic Gases: First Aid and Treatment.* Lyndhurst, NJ: Matheson Gas Products, 1977.

*The Merck Index, 12th Edition,* Merck & Co., Inc., 1996

*Fire Protection Guide on Hazardous Materials.* Quincy, MA: National Fire Protection Association, 1993.

*Flammable and Combustable Liquids Code .* Quincy, MA: National Fire Protection Association, 1993.

*Safe Handling of Compressed Gases in Containers* (Pamphlet P-1). Arlington, VA: Compressed Gas Association, Inc., 1991.

**Revision Information**

Section 7, Handling and Storage and Section 15, TSCA Status have been revised.

**Disclaimer**

Voltaix, Inc. cannot guarantee that these are the only hazards that exist. Users are solely responsible for the safe storage, handling, use and disposal of this material, and for compliance with the applicable laws, regulations and accepted practices.

Voltaix, Inc. makes no representations or warranties, either expressed or implied, of merchantability, fitness for a particular purpose, or any other nature.